PATENT

Serial No.: 09/160,991
Filed: September 25, 1998
Group Art Unit: 3724
Examiner: Hwei-Sui Payer
Applicant: Zhang et al.
Title: CUTTING DIE AND METHOD OF FORMING
Atty. Docket: BERL-18A

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Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

DECLARATION OF NONOBVIOUSNESS
UNDER 37 C.F.R. §1.132

I, Dr. C. Rey Hsu, hereby state and declare the following:

I received a B.S. in 1981 and a M.S. in 1986 in Physics, with an emphasis in laser optics, from Fu-Jen Catholic University in Hsing Chunf, Taipei, Taiwan. I received a M.S. in June 1991 and a Ph.D. in 1996 in Welding Engineering from The Ohio State University, with a major in Laser Materials Processing and Minors in Weld Design and Electrical Engineering. I am a member of the following professional organizations: American Welding Society, Laser Institute of America, Fabricators and Manufacturers Association International, IEEE, Peer Review Committee of the Journal of Taiwan Cutting and Welding, Peer Review Committee of the Gulf Coast Maritime Technology Center of the University of New Orleans, and visiting professors at Harbin Research Institute of Welding in China. I have published over 30 articles in laser welding and cutting areas, hold 2 patents and two pending patent applications.

I have been employed by Bernal, Inc. since November, 2002. From 1999-November 2002, I was a General Manager for Focal Laser Innovative Solutions, LLC, which is

in the business of development and implementation of laser technologies to a wide range of applications. During that time, I consulted with Bernal, Inc. on their laser cladding technology. From 1997 to March 2001, I was Senior Project Manager for the Laser Welding and Cutting Group of Fraunhofer USA, Center for Laser Technology. For two years prior to that, I was Project Engineer in the same group. From 1988 to 1995 I was a Graduate Research Associate at the Ohio State University. In 1987, I was a Design Engineer for Delta Electronic Industrial Inc., and from 1985-1986 I was an Optical R&D Engineer for Pacific Laser Electro-Optics Inc. Through my education and professional endeavors, I have developed expertise in the following areas: Laser Welding, including that commonly used on the Photonics industry for glass-to-silicon welding; laser materials processing, welding metallurgy, laser training, and laser optics.

I have reviewed and understood the subject matter of Bernal's pending U.S. Patent Application No. 09/160,991, Baker U.S. Patent No. 3,952,179 and Maybon U.S. Patent No. 4,323,756. I make the following comments based on my education, knowledge and industrial experience in the laser processing and welding fields:

1. Bernal's pending patent application discloses a laser cladding process, while Baker's patent discloses a welding process. As stated in my prior declaration, welding processes generally involve a large amount of heat being induced in the materials in the surrounding area of the weld, resulting in distortion and cracking to the product. The welding process also induces a large amount of residual stress in the die body and blade, which can cause cracking and corrosion. Distortion and residual stress also will cause the blade to actually move during operation of the cutting die, which causes tolerance problems. I believe the laser cladding process disclosed in the application provides a solution to these technical difficulties. The laser induces only

a small amount of localized heat at the surface of the die body, causing little to no distortion of the surrounding area, and inducing little to no residual stress.

2. The laser cladding process disclosed in the pending application is an accurate, highly controllable deposition process that is capable of producing a near net shape. Near net shape is a term of art referring to a shape that is close to the final desired shape, and which requires only a small amount of material removal after the original deposition. Welding, on the other hand, involves large, wide beads of deposited material that are hard to control with respect to defining a precise shape and providing accuracy and consistency. To produce a blade by welding, the deposited material must be subjected to significant machining after deposition due to the general messiness of the process. Laser cladding as disclosed in the application requires only modest machining to define the blade from the deposit due to the near net shape capability of laser deposition.

3. To illustrate the difference between the near-net shape of the present invention and the welding method of Baker, the depiction in Figure 1 (attached hereto) schematically shows a blade deposited by laser cladding in accordance with the present invention, before and after shaping of the blade and a blade deposited by arc welding in accordance with Baker, before and after machining. In manufacturing cutting dies in accordance with Bernal's pending U.S. Patent Application No. 09/160,991, Bernal has experienced 24-80 hours savings in EDM removal of the deposited metal to obtain the final blade shape, depending on the complexity of the blade design, compared to the conventional welding method disclosed by Baker. The

reduction in manufacturing time translates to an approximately $3000 savings per die, which is a 10% savings in manufacturing cost.

4. The depiction in Figure 2 (attached hereto) shows a photograph of an actual metal sample having a laser deposit thereon, before and after machining, and a weld deposit thereon, before and after machining. The base metal is the same type of metal typically used for the die body of rotary cutting dies, and the laser and weld deposited materials each have hardness greater than the hardness of the base metal. The machining, for illustration purposes only, consisted of grinding off a surface portion of the deposit. Figure 2 illustrates the precision and accuracy with which a material can be deposited and a structure can be wholly formed on a body surface using the laser cladding method of the pending application. Figure 2 further illustrates the lack of precision and messiness associated with the welding method used by Baker, the need for far greater material removal to form a final shape, and the heat distortion suffered by the base material from the high, uncontrolled heat of the welding tool.
5. The method of Baker is impractical because welding processes cannot deposit the hard carbide-containing materials that can be deposited by the laser cladding process and that are needed in the industry for long cutting blade life. The highly abrasion resistant materials, such as carbide-containing materials, are expensive and are subject to cracking and porosity when deposited by welding due to the large heat input inherent in the welding technique. Thus, high-speed steels are typically used in weld deposits for blades despite their lower abrasion and wear resistance. In addition, the significant machining required by virtue of using a welding process is timely, costly and difficult. Due to the waste of blade material

resulting from the excessive machining required by the welding process, die manufacturers steer away from the better but more expensive blade materials due to high material waste costs. For a cutting die produced in accordance with the pending application, a hard material can be deposited and easily and quickly machined due to the low amount of machining required with a near net shape deposit. Only the near-net shape deposits achieved by laser deposition enable a cost reduction sufficient to make the use of the expensive materials practical.

Further Declarant sayeth naught.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 5/25/2004

C. Rey Hsu, Ph.D., Director of R&D
Bernal Inc. /A Cerutti Group